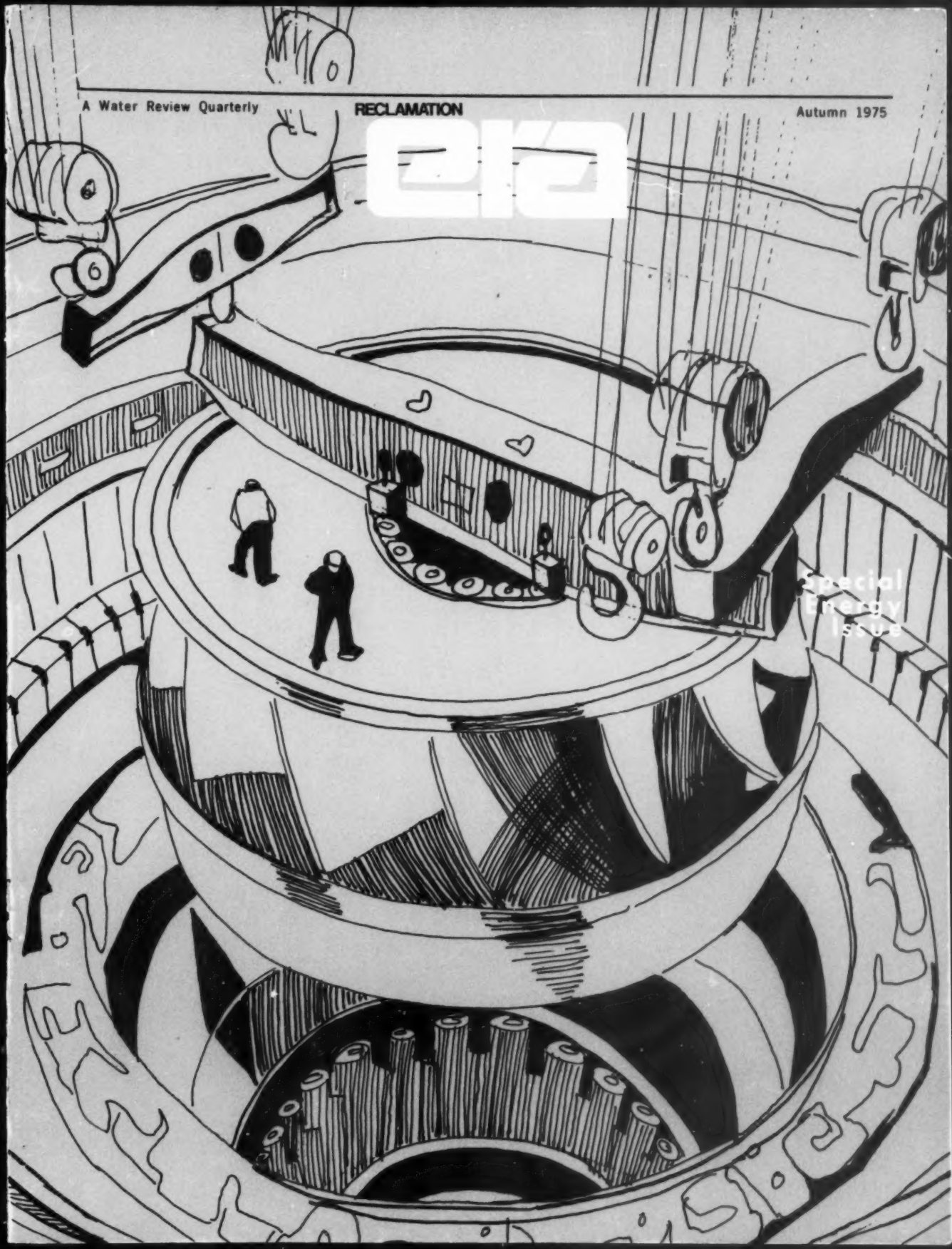
A Water Review Quarterly

RECLAMATION era

Autumn 1975



special energy issue

RECLAMATION
era

Autumn 1975

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Kathy Wood Loveless

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The Third Powerplant at Grand Coulee Dam in Washington is expected to become the world's largest hydroelectric power complex with a total of about 10 million kilowatts of installed capacity.

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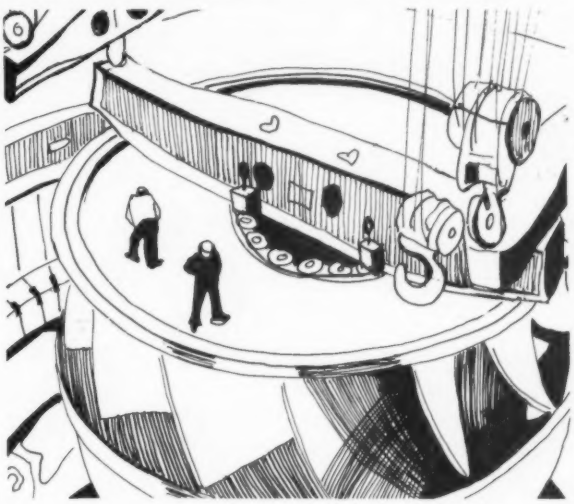
A Braggart's Delight

Startup of the Third Powerplant

by Hu Blonk



Among the several thousand people who were the happy participants in the start-up of the Third Powerplant at Grand Coulee Dam this October 11, the most pleased probably were the sons and daughters of men who 40 to 50 years ago fought against what seemed insurmountable odds to bring about this massive structure.

They, plus a dwindling group of people who actually participated in the long struggle to irrigate the Columbia Basin and put the Columbia River to work at the mouth of a dry gorge from which the dam got its name, remember how it was way back when:

—a leading national business magazine said, "Grand Coulee Dam is typical of those things that won't have any more usefulness than the pyramids of Egypt;"

"Grand Coulee Dam is typical of those things that won't have any more usefulness than the pyramids of Egypt."

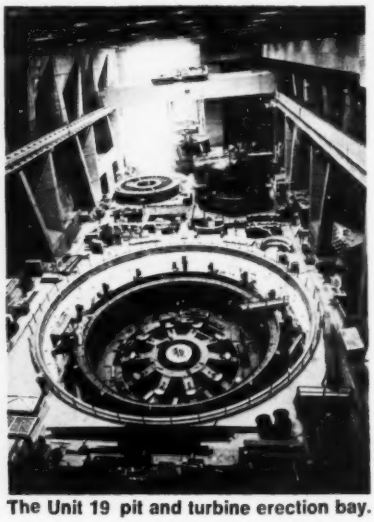
—a U.S. Congressman stated that the project was "the most colossal fraud in the history of America;"

—and another skeptical, popular magazine asked, "What are you going to do with the electric power generated in the heart of deserts? . . . How about industry? Where is it coming from?"

These quotations, when recalled on October 11 may have seemed ludicrous and shortsighted for on that day another milestone was reached in the great project's ever-increasing

Hu Blonk is the Chairman of the Third Powerplant Startup Committee. He is the former managing editor of the Wenatchee World and former Chief of Publications for the Bureau of Reclamation, Washington, D.C. Recognized for his contributions to society and the press, he has received numerous awards, including the Bureau's "Citizen Award."

The cable spreading yard at the Third Powerplant.



The Unit 19 pit and turbine erection bay.

significance in the production of power to meet constantly-growing demands not only in the Pacific Northwest but in distant Southwest States.

On that day the first huge generator of perhaps a dozen that will once again make Grand Coulee Dam the world's largest power producer was put on the line.

What a contrast it is with what transpired in the late 20s and 30s. The only work done by the river that the Indians called "Chiawana" was insignificant. At the site of the Grand Coulee Dam, the river's current was used to push Sam Seaton's cable ferry from shore to shore when the well-worn vessel was turned at an angle against the flow.

Now the Columbia is turning the world's largest hydroelectric generator. It is so large a machine that the human mind cannot fathom its size unless comparisons are made.

It is 180 feet high (18 stories) and 77 feet in diameter (as wide as four cars parked end to end)!

The hydroelectric generator is 180 feet high (18 stories) and 77 feet in diameter (as wide as four cars parked end to end)!

It has a rated capacity of 600,000 kilowatts (kW). That's enough to meet the power demands of an average city of 500,000 people (later units will be even bigger—700,000 kW).

While Sam Seaton's old ferry required little water, the newest Grand Coulee turbine will be driven by a whopping 30,000 cubic feet of water per second—the equivalent of eight railroad tank cars full.

The huge volume will come hurtling down a 40-foot diameter steel tube encased in concrete. If the ceiling of your living room is 8 feet high, that tells you the diameter of this penstock is five times that height!

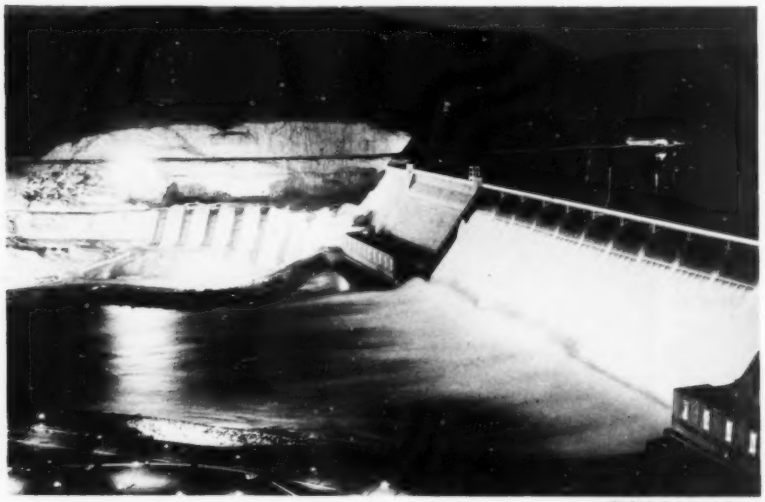
In other ways also, Grand Coulee's new generator is a braggart's delight.

The revolving section of the mammoth dynamo, which consists of a 32-foot-diameter waterwheel connected by a great shaft to a rotor overhead, weighs a staggering 2,200 tons. That is the equivalent of 10 of the largest diesel locomotives used by Amtrak.

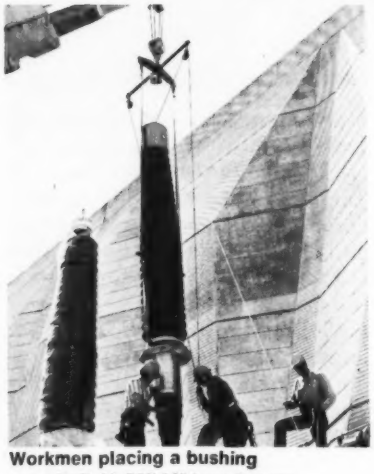
The shaft that joins the turbine runner (as engineers call the waterwheel) to the rotor that spins inside a stationary circle of coils called the stator, is 9 feet in diameter. Referring back to your living room, that is a foot higher than your ceiling.

Eventually the Third Powerplant will house three of these large power-making machines, plus three 700,000-kW units. A new generator will be ready for service about every 6 months.

By 1978 all six will be turning. A study is now underway to determine the economic and engineering feasibility of more than doubling the Third Powerplant capacity by installing additional units.



Third Powerplant as it looked 5 years ago.



Workmen placing a bushing on a Unit 19 525-kV transformer.

The project was authorized by Congress in June 1966, as a 3,600,000-kW installation, involving a dozen smaller-size generators, each rated at 300,000 kW. It was subsequently determined that 600,000-kW and even 700,000-kW units were feasible by bringing the parts to the site and assembling them there. The forebay dam has been built to allow installation of an additional six units by extending the Third Powerplant. If authorized by Congress, its total capacity could be about 8,100,000 kW.

A new generator will be ready for service about every 6 months. By 1978 all six will be turning.

That total added to the 2,229,000 kW in units turning in the two older powerplants will once again make Grand Coulee Dam the world's greatest power producer. It lost that distinction a few years ago when the Soviet Union put to work some of its big Siberian rivers.

The projected nameplate rating total will be more generating capacity than exists in all the other 50 powerplants that the Bureau of Reclamation has built since it became the major water resource development agency in the West back in 1902. And that includes Hoover Dam, Shasta, Hungry Horse, Glen Canyon and other large power producers.

The initial six authorized units are actually to be housed in half of a powerhouse—1,128 feet long, 150 feet wide, and 230 feet high. Ultimately a structure 2,050 feet long, about eight city blocks, and of the same height and width as the existing structure will be needed—one of the largest concrete buildings in the West.

The new power facility required a forebay dam to impound an excavated arm of the 9½-million-acre-foot Lake Roosevelt. Full power development will require an extension of the dam. The gravity-type structure now in place is 1,317 feet long and 200 feet high.

A large 500,000-kV switchyard for the initial three powerplant units has been completed on a high bluff that rises approximately 1,000 feet above the crest of the Grand Coulee Dam. The added switchyard capacity for the additional three generators authorized is being built now. The switching for the final six units will be designed to dispatch power at 700,000 kV. Both of these voltages are the highest in operation in the world.

The project stands as an outstanding example of what can be accomplished by two friendly nations working together. It became feasible because of the cooperative development of the water resources of the Columbia River provided for under a

The project stands as an outstanding example of what can be accomplished by two friendly nations working together.

The Third Powerplant will produce more generating capacity than exists in all the other 50 powerplants that the Bureau has built, including Hoover, Shasta, Hungry Horse, and Glen Canyon.

United States-Canada treaty signed in 1961. Implemented in 1964, it called for the construction of four major storage dams, the water from which would be released during periods of high seasonal power demand for increased power production downstream.

The last of the four—Libby in northwestern Montana — was completed in August, the three in Canada having gone into operation earlier. These four dams provide 20½ million acre-feet of additional storage—double that of the existing river system.

While Grand Coulee's Third Powerplant will have an enormous power-producing capability, the units actually will turn only part of the time, mostly in the late afternoon when the kids come home from school and turn on the TV set, Mother starts cooking, and the heating thermostat is turned up. This calls for additional power beyond what industries, stores, and homes consume during other parts of the working day.

The units in the existing Grand Coulee plants can't make effective use of all of the usable water provided for under the treaty. With the Third Powerplant in operation, however, maximum prime power will be obtained from improved river flow. In addition, substantial quantities of usable secondary power will be produced which would be wasted were only the existing installation to continue in use.

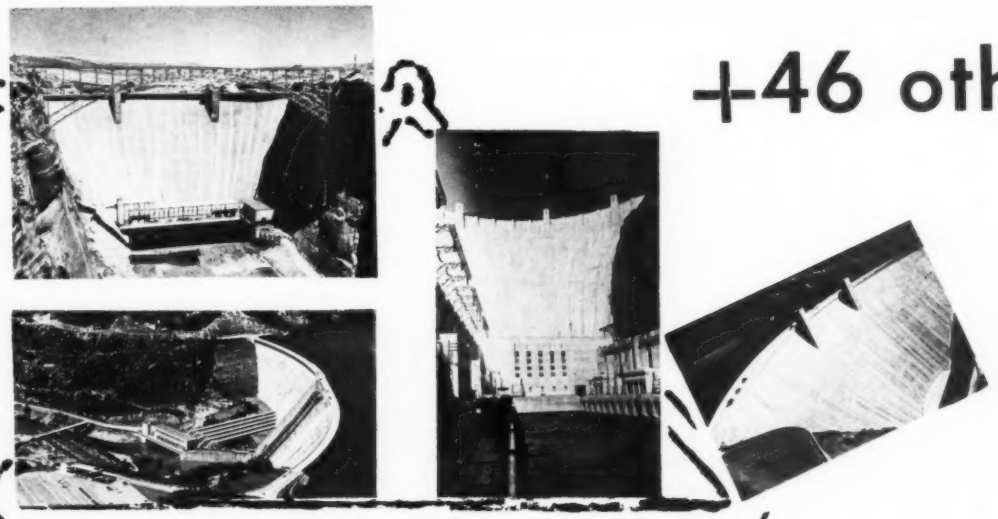
And hydroelectric power is pollution-free!

Some laymen have difficulty understanding why some generators in hydroelectric powerplants are made to stand idle most of the day unlike those in powerplants that consume coal, oil, or gas. The reason is that the latter plants operate most efficiently when run at a constant rate, and water-driven facilities can be more easily turned off and on. Furthermore, reservoirs can be refilling when the units are not turning.

And hydroelectric power is pollution-free!

The Grand Coulee installation will constitute 22 percent of the peaking capacity of the Federal hydropower system when the 31 dams plus hydro and thermal power facilities in the region are completed in 1978 and 1979. And that's quite a role to fill.

The Third Powerplant project, as currently authorized, will cost $490 million. In the early days before the authorization of Grand Coulee Dam much was made of the poor taxpayer having to foot the bill. If such critics could only be at the dam now to take a look



at a display board across the river from where the Third Powerplant ceremony was held!

It depicts, second by second, just how much money the project is bringing in. The dollar figures roll by at the rate of $70 to $90 per minute.

Grand Coulee's new addition will have a remarkable payout, too. Annual revenues from the sale of system power added by the Third Powerplant will exceed by an average of nearly $4 million per year the annual cost of the Third Powerplant.

Saying it another way, the project's cost will have been completely repaid, with interest, in 36 years. And by the end of the conventional payout period of 50 years, it will have earned a surplus of some $265 million to be applied to Reclamation's projects or to accumulate in the Federal Treasury.

That's a pretty good investment for the "poor taxpayer," most folks would admit.

By the way, visitors are able to see where their money went when construction is completed. An inclined elevator has been provided on the face of the forebay dam. The glass-enclosed conveyance will travel 465 feet to the lowest level of the powerplant where there are tourist stops enroute.

The display board depicts, second by second, just how much money the project is bringing in. The dollar figures roll by at the rate of $70 to $90 per minute.

It is expected that the ride will be one of the most interesting aspects of the Bureau of Reclamation's new tour of the Grand Coulee Dam. The added facilities are being provided to meet the anticipated huge demand of the public to see what Uncle Sam has wrought.

To sum up, the Third Powerplant is a key factor in the struggle of power producers, public and private, to keep up with power demands. The predictions are staggering. In the next 20 years, peak demand and generation is expected to triple, from 20 million to 60 million kW.

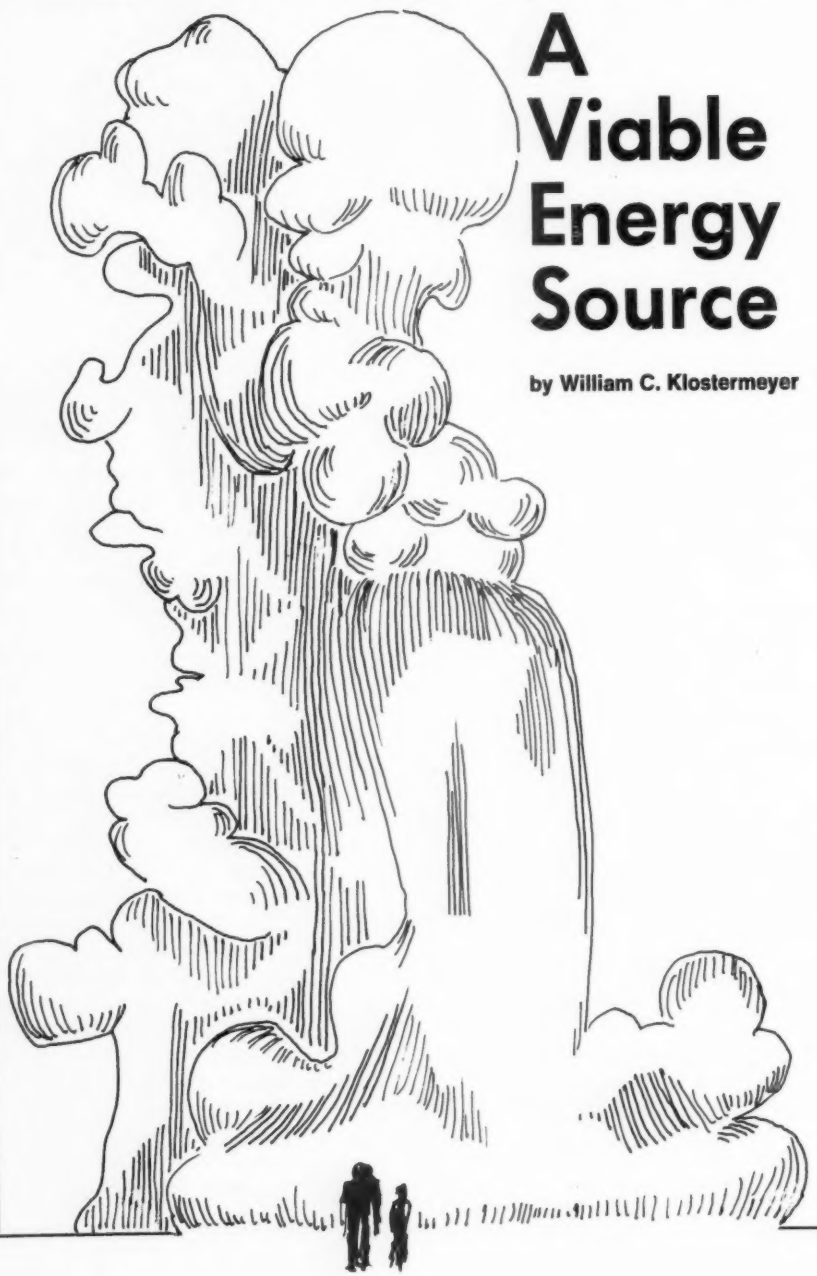
Past predictions such as the above have proven far more accurate than those of the skeptics of the 1930's, among which was a national magazine of huge circulation which told its readers that the generators at Grand Coulee Dam would be producing "power in the wilderness . . .,"

Continued on inside back cover.

GEOTHERMAL

A Viable Energy Source

by William C. Klostermeyer



Geothermal is a word with which Americans will become increasingly familiar.

Why? Because geothermal energy may become a major source of energy in the near future—a source which will supply, along with other energy sources, the vast amounts of electrical energy consumed by Americans. Geothermal energy may be partially responsible for allowing Americans to maintain their current standard of living. Geothermal resources are unique in that they

Geothermal resources are unique in that they can be economically and environmentally feasible.

can be economically and environmentally feasible. They also have multiple-use potential—as sources of energy, water, and minerals.

The word geothermal means "heat of the Earth." Probably the most well-known surface manifestation of geothermal energy is the Old Faithful Geyser in Yellowstone National Park. There, the heat of the Earth raises the temperature of subsurface water high enough to turn some of it into steam, and the geyser erupts spewing forth steam and hot water.

William C. Klostermeyer is Assistant Chief, Division of Program Coordination and Finance, and a former Chief, Resources Planning Branch, Division of Planning.

Man has probably made use of hot springs and hot caves ever since his beginning. The inhabitants of ancient Greece and Rome used the heat from hot springs to heat buildings. Hot springs have always been popular sites for resorts and spas. White Sulfur Springs in West Virginia is just one example of the many resorts in this country. Visitors can relax in pools filled with warm, soothing water straight from Mother Nature, while enjoying majestic scenery usually found at such resorts.

Primitive, native New Zealanders used geothermal pools for cooking. Directions for cooking in a geothermal pool might have read something like this: Prepare foodstuffs in desired manner. Place in some sort of sack. Tie sack securely. Place in geothermal pool. Cook until done. Remove, taking care to avoid scalding nearby persons. Drip dry.

But geothermal resources have still another potential which has yet to be fully developed—its potential as an energy source.

The major problem associated with geothermal energy is that it is relatively immobile. The powerplant must be located near the source of energy; one cannot move the source of energy to the site of the powerplant.

Geothermal energy exists in several forms. The form most easily and directly used for the production of electricity is "dry steam," steam with low water content. Dry steam is created when abnormal heat flows through the Earth's crust, heating subsurface water to the vapor point. When these sources of steam are tapped, the steam can be captured and used to drive

The inhabitants of ancient Greece and Rome used the heat from hot springs to to heat buildings.

conventional steam turbines to produce electricity.

While it is relatively easy to develop the dry steam resource, there is a limited number of known dry steam areas in this country. The Geysers area (north of San Francisco), the Lassen Volcanic National Park area in California, and the Yellowstone area are the only areas which are known to emit dry steam. Both the Yellowstone and Lassen Volcanic National Parks are permanently withdrawn from exploitation. Dry steam in The Geysers area of California is being used to produce about 400 megawatts of electricity. This is approximately half of the amount of electricity needed to light a city the size of San Francisco.

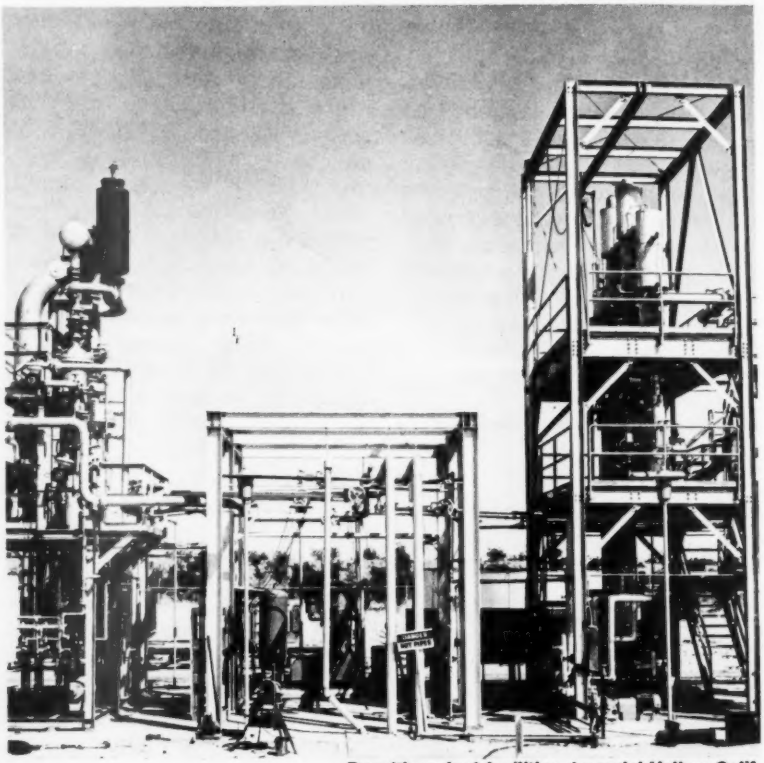
Another form of geothermal energy, which is more common than dry steam, but which is more difficult to convert into electrical energy than dry steam, is the hot water system (a combination of steam and water).

This mixture occurs where the subsurface heat does not raise the temperature of all the water to the vapor point. Old Faithful is a good example of this type of geothermal energy. Both water and steam are emitted from the source. Mexico and New Zealand use this type of geothermal energy to produce electricity.

The processes used to convert energy from a mixture of steam and water into electrical energy are more complicated than the process used when dry steam is the heat source. The conventional means of producing electricity

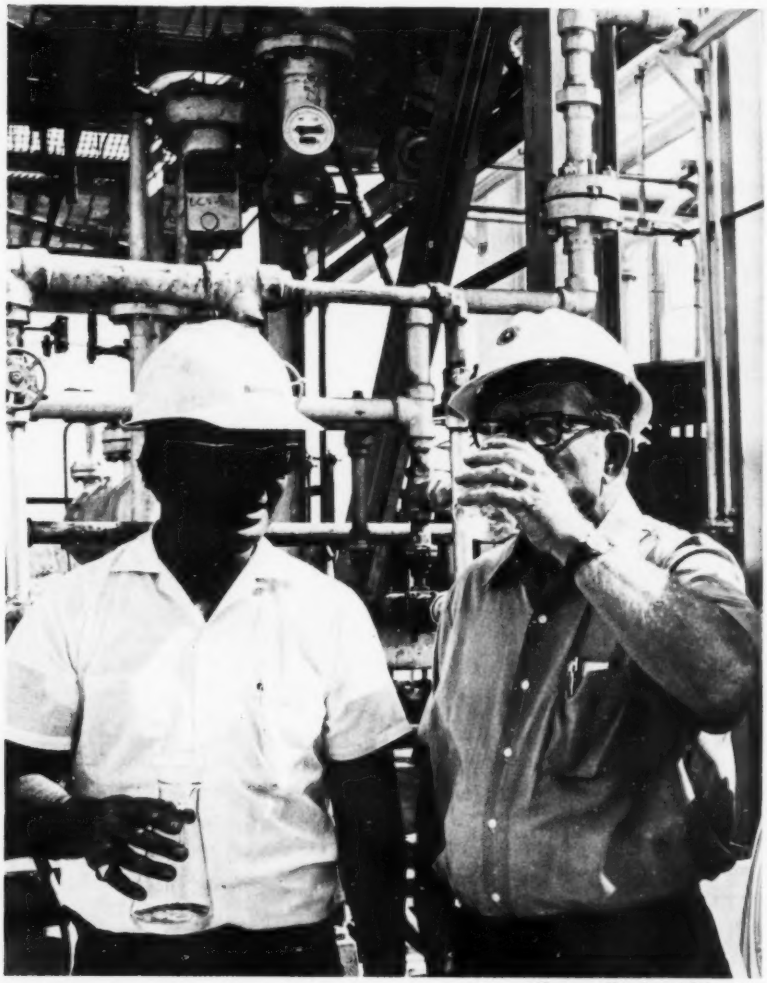
Old Faithful is a good example of geothermal energy.

Old Faithful.



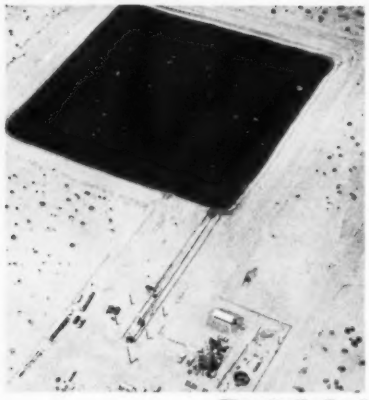
Desalting plant facilities, Imperial Valley, Calif.

Sampling the desalted water.

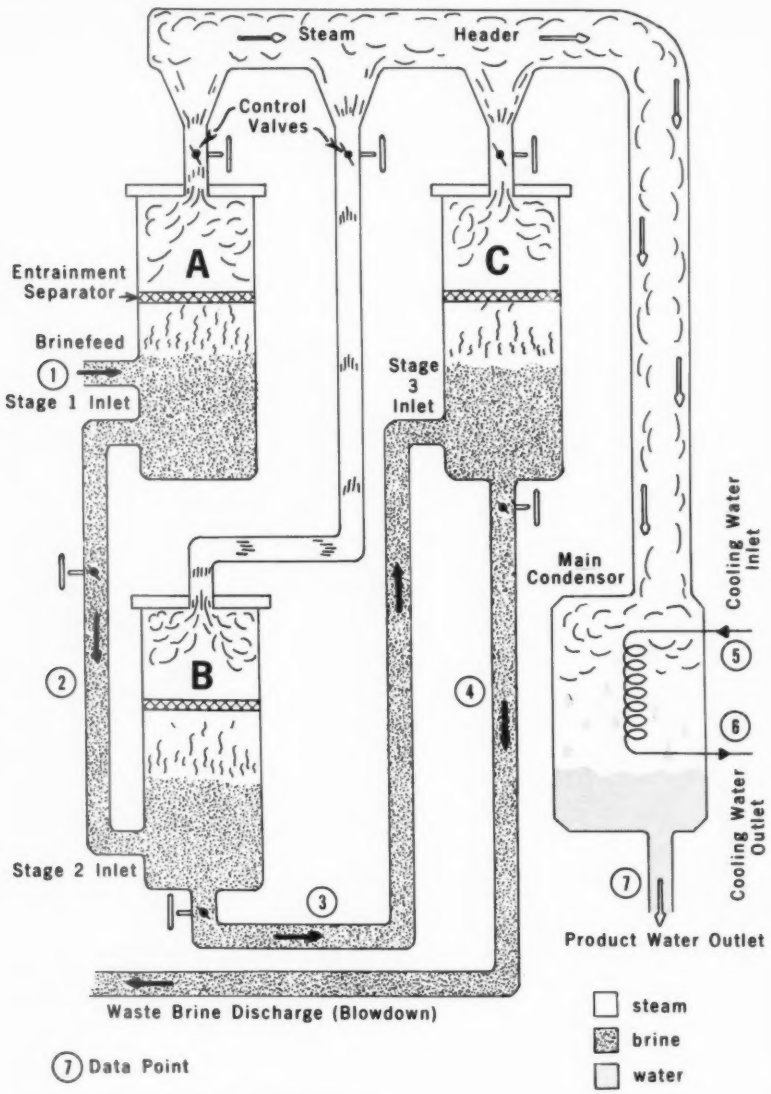


Former Regional Director of the Lower Colorado Region, Edward A. Lundberg, tastes the distilled water.

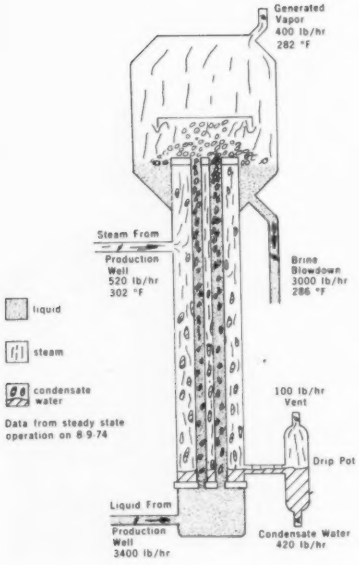
Fluid and steam emerging from the geothermal well.



The plastic-lined brine holding pond.



The multistage flash distillation process.


Generated Vapor 400 lb/hr 282 °F
Steam From Production Well 520 lb/hr 302 °F
Brine Blowdown 3000 lb/hr 286 °F
liquid
steam
condensate water
Data from steady state operation on 8-9-74
100 lb/hr Vent
Drip Pot
Liquid From Production Well 3400 lb/hr
Condensate Water 420 lb/hr

The vertical tube evaporator unit.

is to separate the steam from the water through "flashing" and then to use the steam as one would in a dry-steam system. The remaining hot water is then wasted or used as a heat source for something other than producing electricity. A system that would better utilize the resource would use the steam-water mixture without separation—directly in an impulse turbine (or some other total flow system), or in a binary process (which uses a heat exchanger to heat a secondary liquid). In the binary process, the secondary liquid is the force which actually turns the turbine. And in a binary system a greater amount of the heat energy is used to produce the electric energy.

The hot dry rock is another type of geothermal energy which has yet to be developed. This phenomenon occurs when the heat source raises the temperature of surrounding rocks and when there is no natural subsurface water present. The major problem with the development of this form of energy is the lack of a means by which one can transfer this heat to the Earth's surface and into conversion hardware.

The Geological Survey maintains that the hot dry rock resource is the most prevalent source of geothermal energy. Currently, the Energy Research and Development Administration is making studies in New Mexico concerning the development of heat recovery techniques for hot dry rock systems.

The problem of subsidence can be eliminated or reduced by reinjecting the brines recovered from use of the geothermal resource.

The geopressured system is another thermal resource. In the United States, such a system exists primarily along the Gulf Coast. This system is a geologic formation where the normal heat flow of the Earth is trapped by insulating impermeable clay beds in a rapidly subsiding geosyncline or downward bend of the crust. The water trapped in the system is at high pressure and temperature. Also trapped in the system and a possible byproduct of the system development are large quantities of natural gas. However, technology has not yet been developed for economical utilization of the geopressured resource.

A problem associated with making extensive use of geothermal resources is the possible land subsidence which can occur when geothermal liquid (water and brine) is withdrawn from its subsurface environment. A good example of this phenomenon is Mexico City, which is built on a swampy area. The land there subsides several inches each year because of the depletion of the water beneath the city (Mexico City uses subsurface water as a source of its water supply). A similar subsidence problem exists in many of our oil-producing regions.

The problem of subsidence, however, can be eliminated or reduced by reinjecting the brines recovered from use of the geothermal resource into the peripheral zones of the subsurface reservoir. This would help stabilize and maintain subsurface pressure and it would guard against land subsidence. This also provides an environmentally acceptable use for cooled waste brines.

As in other resource developments, pollution is a problem associated with extensive use of geothermal energy. Gases which are in solution with the water in its subsurface state are injected into the atmosphere when the water or steam is reduced to atmospheric pressures.

In conjunction with energy production, geothermal resources could also be used to augment water supplies in arid lands. The

heat energy from geothermal resources could be used to run the desalting plants needed to produce fresh water from the geothermal brines.

The Bureau of Reclamation is exploring geothermal resources in the Imperial Valley of southern California, in an attempt to investigate the feasibility of desalting mineralized geothermal fluids. The results of these studies will be used to evaluate alternative water sources in the water-short Pacific Southwest as well as any other water-short area where there is a hot water geothermal resource.

The Colorado River Basin could benefit from such a development. The Colorado River Compact allocates more water to the States of the basin than has been available in recent years. To add to this problem, the Colorado River Basin lands are of a high salinity. Runoff from these lands increases the already high salinity of the river. Projections indicate that Colorado River waters will be unfit for present uses without a major quality improvement program in the near future. Thus, desalinated waters could augment the short supply and also decrease the degree of salinity of Colorado River water.

The Bureau of Reclamation and the Office of Water Research and Technology have installed and are testing two desalting plants in the East Mesa geothermal anomaly area of the Imperial Valley. Both operate on the principle of condensing steam to obtain water. One is a multistage flash distillation unit, which consists of a series of flash chambers, each of which operates at an ambient pressure that is lower than the pressure in the preceding tank. The vapor from each stage is collected and then condensed into the final product—desalted water.

The hot dry rock is another type of geothermal energy which has yet to be developed.

The other plant is a vertical tube evaporator distillation unit. This consists of a flash tank which also houses a bundle of tubes. As hot geothermal liquid flows through these tubes, it flashes down to a lower temperature and pressure, thus generating vapor. At the same time, steam surrounding the tubes evaporates additional vapor from the brines and condenses as it transfers heat to the brine. This type of unit can exist as a single unit or as a multistage unit.

The Bureau is operating the two test units under various conditions in order to better understand the resource and the problems associated with its utilization and to develop the necessary technology and design criteria to construct a demonstration-size plant.

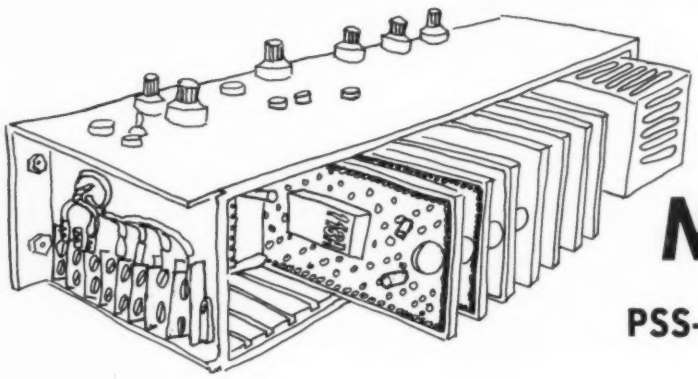
To expedite research into the use of geothermal fluids to produce energy, the Bureau plans to expand its desalting research facility at Yuma, Ariz. It will be made available as a national test site where private industry, universities, and Government agencies can experiment with the potential of geothermal energy resources.

In discussing the use of geothermal resources, one sometimes overlooks one of the most obvious facts about the resource —that it is hot. This alone opens up many potential uses that will contribute to the improvement of the country's overall energy picture.

Additional uses of the geothermal resource can be for home heating or air conditioning, industrial heating and cooling, agriculture, and for many other areas now using oil or electricity as the energy source. This conversion will free a part of our supply so it may be used where geothermal resources are not available. While it has been pointed out that the resource cannot be moved around, in some cases potential users could easily move to the resource, thus providing the needed flexibility.

The last of the many known benefits of geothermal resources is the possible recovery of minerals and chemicals which are carried by most geothermal liquids. Some private concerns have attempted recovery of mineral salts in the Salton Sea area using open ponds and solar evaporation. Studies are being conducted to look at the production of minerals as the final step in a multicycle system for using geothermal resources. In fact, several foreign countries have attempted to extract precious metals such as gold, silver, and platinum from geothermal brines.

Geothermal—not only a word, but a viable energy source with which Americans will become familiar.



Big-Little Magic Cubes

PSS—Power System Stabilizer

by Charles A. Knell

In 1967, the Bureau of Reclamation unwrapped a "big-little" magic cube that has, after 8 years of widespread use, proven to be a significant contribution to smooth and reliable operation within and between interconnected electrical power systems in the Western United States.

"Big-little" appears to be a paradox—how can an object be both big and little at the same time?

C. L. "Chuck" Clemans, Chief, Electric Power Branch, at the Bureau's Engineering and Research Center, Denver, Colo., said, "The answer to that one is easy—it is little in size when compared to the big job it is doing."

The magic cube is an ingenious little gadget, originally one cubic foot in volume, designed to detect power oscillations before they become dangerous. It was invented by Ferber Schleif, former Chief of the Electric Power Branch, Division of Research, Bureau of Reclamation, now retired.

Charles A. Knell is the Field Public Affairs Officer, Bureau of Reclamation, E&R Center, Denver.

Schleif's invention is patented, but in the public interest Reclamation has waived royalties and "magic cubes" are now being manufactured in varying sizes and shapes.

Each cube contains an assortment of amplifiers, power supplies, transistors, wires and circuit boards — much like the inside of a television set, minus the picture tube.

How can an object be both big and little at the same time?

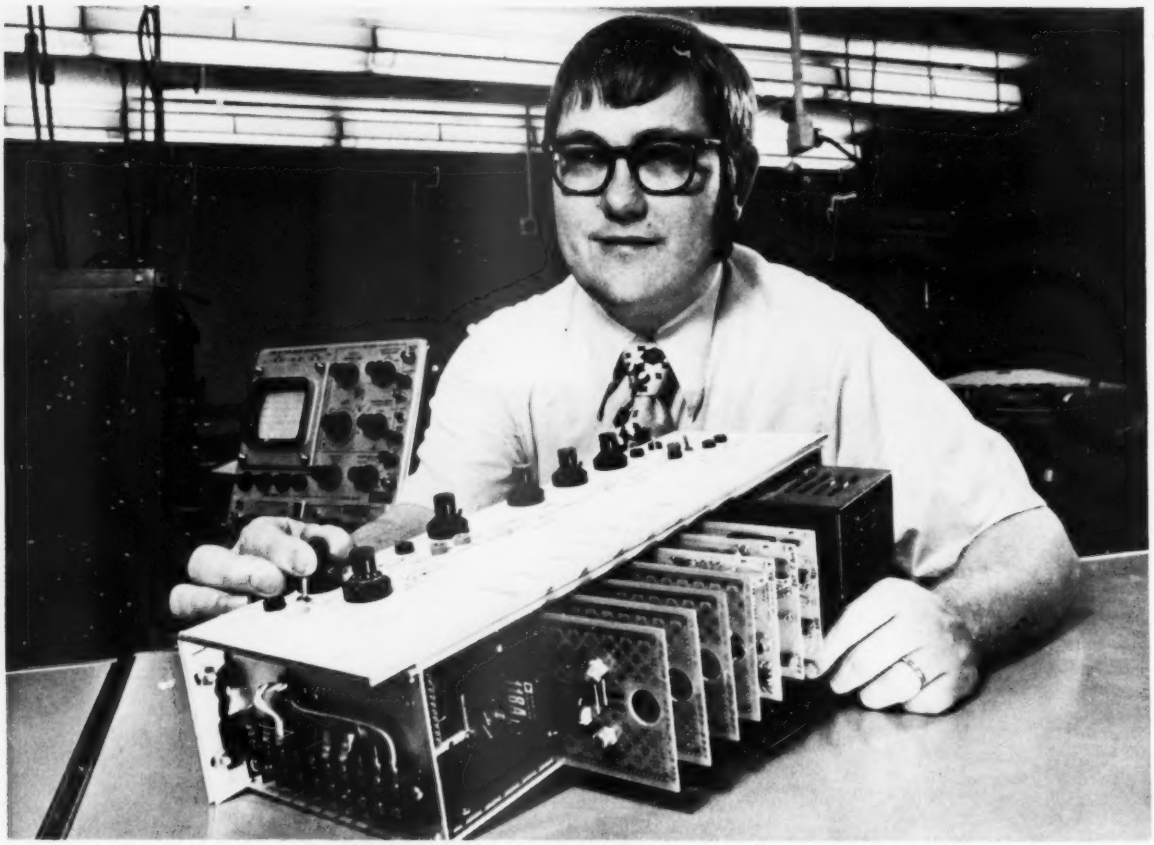
The basic function of each cube—technically called a Power System Stabilizer (PSS)—is to control momentary power flow from a generator or group of generators so as to suppress power system oscillations.

Oscillations are abnormal surges of power that rapidly deviate to the high and low sides of normal. Unchecked, they can grow to such magnitude as to cause widespread power system breakup, sometimes resulting in blackouts or brownouts.

Inside the PSS is electronic equipment which enables it to anticipate the magnitude of an oscillation and to change the voltage of a generator to counteract the buildup that is going to take place unless something is done to prevent it. The device is so sensitive it will change the voltage of a generator before an abnormal power flow gets a chance to accelerate and become a major problem.

The electric power industry has accepted the design principle embodied in Engineer Schleif's PSS. In addition to the Bureau of Reclamation, nearly all operating utilities in the Western United States have installed the "magic cubes." Recently, utilities in the Midwestern United States also have installed this equipment to solve oscillation problems occurring in their area.

The Western Systems Coordinating Council, composed of public and private power entities, is charged with the coordinated operation of western utilities and with the development of criteria for operating standards. It has



William B. Gish, electrical engineer at the E&R Center shows the Power System Stabilizer.

In addition to the Bureau of Reclamation, nearly all operating utilities in the Western United States have installed the "magic cubes."

recommended that PSS be placed on all generators of 75 megawatts or more involved in the Western Systems' coordinated network. At least 75 percent of all such generators in operation at a given time have this special equipment functioning.

The council further recommended that higher levels of PSS installation be in service where it is practicable to further upgrade power system reliability.

William B. Gish, a Bureau electrical engineer at the research labs, has been a leader in the perfection and adaptation of PSS to western power systems. He said, "PSS has become one of the tools necessary to help maintain the system security of our electrically-oriented age."

The pressing need for improvement in power system stability and reliability in the West started with the interconnection of large independent power systems. With that growth, high-voltage electric power transmission lines covering thousands of miles were developed to take the power to the areas with needs. As the system grew, so did the problems involved in keeping these far-reaching facilities free from service interruptions.

John E. Skuderna, Chief, Operation and Maintenance Branch, Division of Power Engineering, E&R Center, Bureau of Reclamation, said, "Some interconnected high-voltage power systems are more susceptible to power oscillations than others, depending on the length of interconnecting transmission lines and the locations and types of generators and loads. In general, the longer the transmission lines become (long lines are common in the Western United States), the greater the tendency for oscillations."

He added, "Power oscillations can start when an abrupt change in power flow occurs. Actually, power flow continually changes because customers are continually switching loads on and off. However, these changes are usually small and cause no problems. Larger changes in power flow, such as those caused by switching major loads or transmission lines, can cause power surging among generators and loads. This surging can cause oscillations which if left unchecked result in system breakdown."

"PSS has improved stability of the interconnected power systems in the West."

In addition to sudden changes in loads, power system short circuits (faults) can also start oscillations. These faults can result from operational problems or from weather conditions, such as violent lightning strikes and lines broken from icing conditions.

A power system with unchecked oscillations can be likened to an automobile with a very bad set of shock absorbers. With every change in road surface the car virtually bounces

A power system with unchecked oscillations can be likened to an automobile with a very bad set of shock absorbers.

up and down and is difficult to control. On a power system that is not precisely "damped" the power, following every fault or adjustment in the system, fluctuates up and down and may increase in intensity and become uncontrollable if left unchecked.

One of the big problems facing engineers in bringing stability to the large western power system was the need for more positive control of these oscillations.

One method of "damping" was already in use in the electric power industry. But, in large western systems it lacked the precise and positive action needed to level out the fluctuating power.

The method of "damping" was to use the generator governor, a device that controls speed. However, the governor's response was too slow to correct all oscillations.

Obviously, the need was for a device that was free from the effects of other equipment and that could provide artificial system "damping" on a continuous basis.

Computer investigations, as well as field tests, demonstrated that the generator's excitation system could be employed to "damp" these oscillations if a precise and controlled signal could be added to the generator voltage regulator error signal. Schleif's "magic cube" provides the sensing and control elements needed to make a voltage control system work.

"PSS has improved stability of the interconnected power systems in the West," said Skuderna.

"The Bureau of Reclamation's power systems and those of other interconnected power agencies now have a more stable delivery of power with PSS.

"Before PSS, instability resulting in service interruptions was of such proportions throughout the vast interconnected western systems that something had to be done," said Engineer "Chuck" Clemans who is now supervising continuing research in PSS for the Bureau of Reclamation.

"This is why Ferber Schleif grabbed hold of the problem when he did and came through with a terrific solution, one that has been wholeheartedly accepted by the industry."

Hydroelectric—Usin

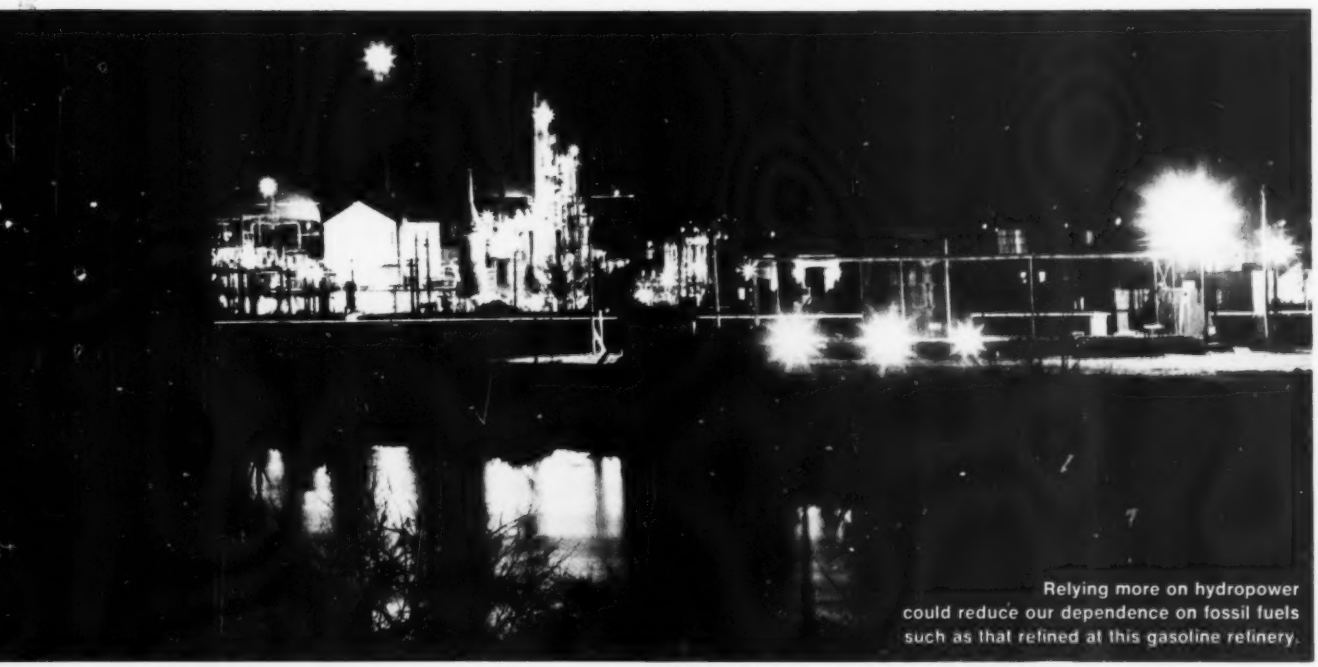
Hydroelectric power, one of the cleanest and most efficient sources of electricity, could play an increasingly important role in the Nation's drive to cut oil consumption and reduce United States dependence on petroleum from foreign suppliers.

The use of hydropower both as a primary source of electricity and as a means to meet peak demands for power in several areas throughout the country is already conserving a significant amount of costly oil. This has resulted in savings for consumers while it has reduced the flow of petrodollars to the Middle East.

Hydroelectric plants currently provide a substantial share of the country's electric power needs, accounting for about 14 percent of total U.S. electricity-generating capacity. In May 1974, 1,428 conventional hydroplants, publicly and privately owned, had an installed capacity of 54.9 million kilowatts (kW). Combined, they were capable of generating an average of 260 billion kilowatt-hours (kWh) of energy per year.

Hydroelectric plants currently provide a substantial share of the country's electric power needs.

While the amount of energy currently provided by hydropower is impressive, it represents only 37 percent of the potential undeveloped conventional hydroelectric capacity of the United States. A Federal Power Commission (FPC) report published in January 1972 estimated the total potential of developed and undeveloped conventional hydrocapacity to be about 178.6 million kW with an energy potential of about 702 billion kWh annually. Undeveloped conventional hydropotential in January 1972 totaled 125.2 million kW with a corresponding average annual energy potential of 445 billion kWh.



Relying more on hydropower could reduce our dependence on fossil fuels such as that refined at this gasoline refinery.

ng Water to Save Oil

Dramatic increases in the cost of fossil fuels have made hydropower development more attractive than ever before.

Although some of that potential may never be developed for a variety of economic, environmental, or other reasons, dramatic increases in the cost and decreases in the availability of fossil fuels such as oil, gas, and coal, coupled with the growing demand for electric power, is making the potential of hydropower development more attractive than ever before.

The cost of electricity in the United States leaped $10 billion in 1974—more than all increases in the previous 25 years. At that rate, by 1980 U.S. electricity will be the most costly in the world.

If only half of the undeveloped hydropower capacity were put to use producing clean electricity, the Ford Administration's goal of conserving one million barrels of oil per day could be achieved from this source alone. Development of even a lesser percentage of potential hydropower capacity would be of tremendous help in meeting the Nation's energy needs, conserving finite resources, and reducing pollution. Such development would also reduce the need for installation of alternative thermal powerplants.

It has been estimated that projects under construction and those that are planned or may be planned in the next two decades could increase hydroelectric capacity by more than 40 percent and the annual generation of energy by 20 percent. It would take over 80 million barrels of oil per year to produce the equivalent amount of energy represented by this increase in hydrocapacity.

Many Federal hydroelectric installations are developed as a

part of multipurpose projects. Benefits are quite often realized in navigation, irrigation, water supply, recreation, flood control, and other related resource needs. Allocation of the costs of building a dam to various functions often can result in a very economic source of power. The operation of multipurpose projects sometimes must be a compromise among project functions. As an example, peaking operations may be limited by water release requirements and environmental considerations.

In addition to the projected increase in hydrocapacity, including both new plants and the expansion of existing hydrofacilities, there is hydroelectric potential remaining in a large number of projects. Some of these projects may be precluded from development by environmental legislation such as the Wild and Scenic Rivers Act. Even excluding those projects and selecting only those appearing to be most favorable, the FPC estimates that as much as 36 million kW of capacity and 100 billion kWh of generation could be developed. This would result in the annual savings of 160 million barrels of oil over equivalent production by thermal powerplants.

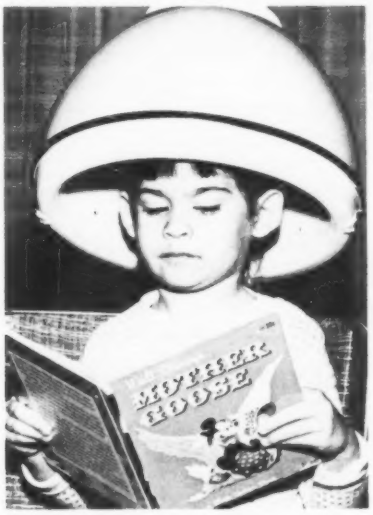
Conventional hydroelectric projects have the advantage of using a renewable resource—water—and producing electric power over long service lives without consuming fuel resources or causing air or water pollution. Another major advantage of hydropower is its ability to supply power on short notice with little loss of efficiency, making hydropower particularly attractive for meeting peak power needs.

If only half of the undeveloped hydropower capacity were put to use producing clean electricity, the Ford Administration's goal of conserving one million barrels of oil per day could be achieved from this source alone.

Pumped-storage hydroelectric projects, which usually function exclusively for peak power generation by acting as a kind of storage battery, are also being constructed to provide peaking capacity. Under this concept, water is pumped from a lower to an upper reservoir in offpeak load periods, and the flow is reversed to generate power during periods when power demands are greatest.* Pumped-storage

Many of America's needs for electricity could be met by using more hydropower.

* See the article, "Tying Solar to Hydro" on page 26.


MEMORIES
HOUSE

RAINBO

projects — those now existing, those under construction, and those planned or identified for possible development in the next 20 years—could provide a total of 41.2 million kW of capacity in addition to the 54.9 million kW of existing capacity added by development of conventional hydroplants.

Conventional hydroelectric projects have the advantage of using a renewable resource—water.

The advantage of pumped storage is that maximum power can be produced during high daily and seasonal power demands. The generating units are able to start up quickly and make rapid adjustments in power output, and they operate efficiently whether they are used for an hour or for several hours.

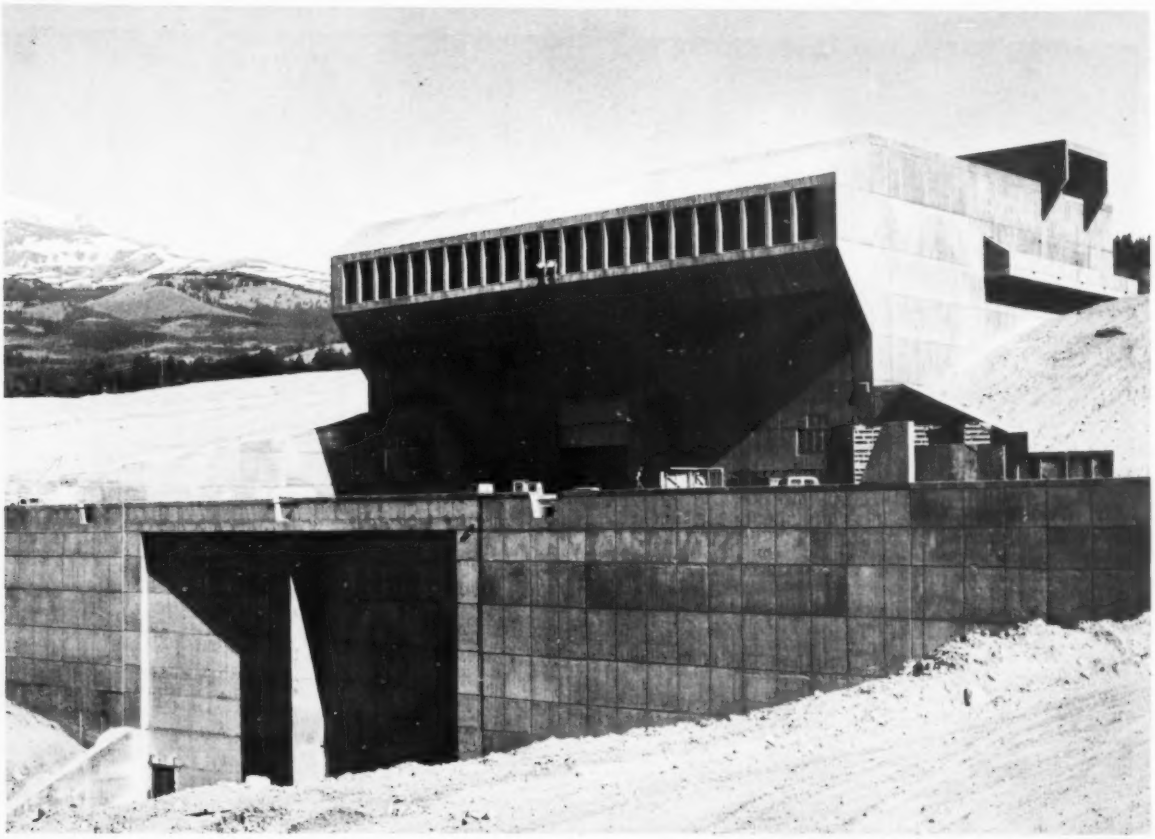
Most hydroelectric projects, either conventional or pumped storage, are ideal for peaking service when operated with large nuclear or fossil-fuel steam-electric units which operate best at high capacity.

This procedure is called "peaking with hydro" and the use of hydropower during times of greatest demand to conserve oil is increasing. Here's how it works.

Suppose you live in a town or city located in an area with hydroelectric power developments. Your local power and light company would provide electricity to heat your home and run the factory where you work. The electricity may come from thermal powerplants that burn coal, gas, or oil, or perhaps from a plant run on nuclear power. These sources are sufficient to meet normal demands, or what is known as the "baseload."

But during the daytime, when power demands are greatest, the utility needs additional power to meet peak consumption. Ordi-

Keswick Dam and Powerplant on the Sacramento River, Calif.



The Mt. Elbert Pumped-Storage Powerplant, Colo.

During the daytime, when power demands are greatest, the utility needs additional power to meet peak consumption.

narily, to meet the additional demand, the power company or utility would have to use or construct peaking plants using relatively inefficient combustion turbines which burn expensive fossil fuels. However, if the power system of your city included hydrogeneration, the power company could use power from hydroelectric plants to meet the need for peaking power and could avoid the burning of expensive and scarce oil.

If the local power company does not have its own hydroelectric plant, it may have the option of purchasing hydropower from others. In some Western States, such purchases might be power from the Bureau of Reclamation. The Bureau operates 50 hydroelectric plants and an extensive transmission system which has numerous interconnections with other utilities and delivery points in the 17 Western States. In calendar year 1974, the Bureau generated 39 billion kWh from these hydroelectric plants.

There are numerous instances in which utilities buy hydropower from the Bureau of Reclamation. Often when the demand goes down at night and the utility has a surplus of nuclear or coal-fired generation, the Bureau purchases power back from the utility to

Transmission lines—the vital link between power generation and power use.

meet its commitments to other customers, thus reservoir water is conserved to generate more hydropower during the next peak demand period.

This arrangement of "peaking with hydro" is already saving a significant amount of oil. Under a Bureau of Reclamation oil conservation program, the use of power from Federal hydroelectric facilities in the Missouri and Colorado River Basins for peaking purposes saved an estimated 5.5 million barrels of oil in 1974 —oil which otherwise would have been burned to meet peak demands for electricity in such cities as Minneapolis or Phoenix.

In addition to saving oil, utility companies and consumers save money because the need for expensive oil is reduced. This is money not spent in the Middle East and does not contribute to a balance-of-payments deficit.

This is especially significant at a time when prices of fossil fuels have almost quadrupled, sending the costs of electricity soaring for both suppliers and consumers. Imported oil, which at one time sold for $2 per barrel, has recently been selling for $12 to $15 per barrel. This fact, together with the national interest to achieve greater energy self-sufficiency, may result in raising the priority for development of hydroelectric power for both peaking capacity and energy production.

"Peaking with hydro" is already saving a significant amount of oil.

Hydropower not only saves oil in meeting peak demands for energy, it saves fossil fuel in meeting the daily requirements for electricity of millions of people throughout the Nation.

The power now being produced and marketed by the Bureau of Reclamation in a year, for example, would meet the residential requirements of a population nearly equal to the com-

Continued on page 30.

Letters to the Editor

Dear Editor:

I have heard that the Bureau of Reclamation is considering a program to preserve historical records of its projects. I'm writing to urge all possible consideration for this exciting and opportune project. We are at a point in history where something needs to be done now or the philosophy of that era will be lost to us and along with that, many fine and worthwhile pieces of Americana that we need to remember in these days of constant change.

Here in Boulder City, as I imagine in other "project-towns," a few starts have been made to preserve the flavor of the 1930's. We are surrounded by a vigorous group of pioneers with vivid memories of the days of dam building. Unfortunately, they are of that age group that is quickly leaving us and with them go their memories of determination, ingenuity, and hard work.

Several people have collected fragmentary parts of the history of the building of Hoover Dam, Boulder City. The Boulder City Branch of the American Association of University Women is working on the living history project and taping the memories of these pioneers (at least 100 are still in the area). The University of Nevada in Las Vegas is encouraging all efforts to collect pictures, news clippings, and tapes. And several individuals are making private collections to aid them in writing about the era. But there is no group to give it cohesion. The Bureau of Reclamation, with its photographs, active retirees, and records is the ideal answer.

I wish I could convey to you the sense of urgency we feel here. Today we are surrounded by vigorous men and women with sharp memories such as Leo Dunbar, hydrographer; Murl Emory, river guide; Irma Godbye, mother and housewife who raised a family in the tent city that preceded our lovely city. Tomorrow all this may be lost along with the ideals and philosophy they exemplified.

Sincerely,

Constance Degernes
Boulder City, Nevada

Dear Editor:

Toast to Reclamation

Here's to a famous Bureau
Whose accomplishments are vast.
Projects it has engineered
Create results that will last.

Bureau of Reclamation
Is the name by which it's known.
Greater water lore has come
From the techniques it has shown.

Great engineers have been bred
From the first-class Bureau's ranks;
Great administrators, too;
All deserve the nation's thanks.

Flooding rivers tamed by dams,
Power from great hydro-plants,
Irrigation from canals
Improve nature's life-style grants.

Greater living monuments
Never have been built by man.
To U.S. Reclamation
Give all credit that you can.

By Eugene V. Read
Grand Junction, Colo.

Yesterday and Today in the ERA

Yesterday
1935

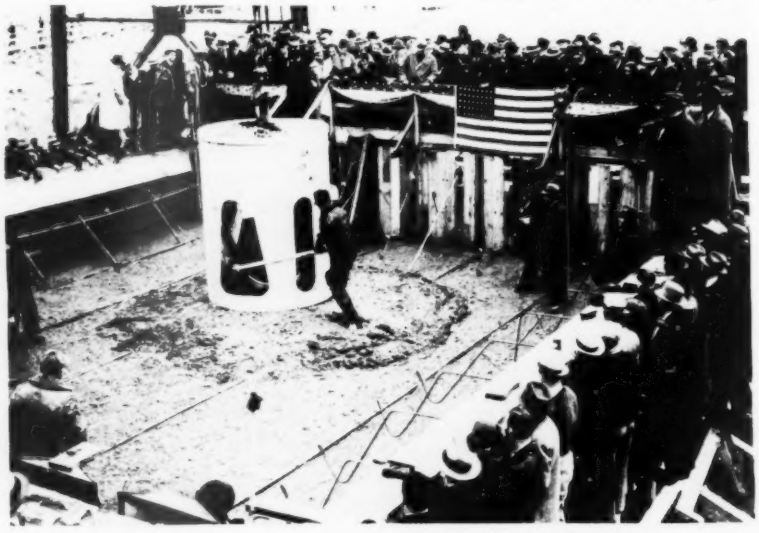
The first bucket of concrete was poured in Grand Coulee Dam in December 1935 with Governor Clarence D. Martin of Washington tripping the catch on the bucket before an important gathering.

"Before Governor Martin pulled the trip cord on the 4-yard bucket," the *Wenatchee World* reported, "A workman more than a mile away on the other side of the Columbia, started the ingenious screening plant. Sand, gravel, and rocks had been sent here from a nearby pit dug by a 5-yard shovel. The mixture was washed, the boulders crushed and classified, and the sand screened, all in automatic operations.

"A long belt conveyed the material across the river to storage bins, near where blended cement and water also were stored. More automatic operations delivered the cement, sand, gravel, and water to the 'house of magic'—the mixing plant, where machinery operates almost as if by magic—in response to operators pressing buttons. The properly-proportioned mixture was dumped into the mixing drum. It turned for exactly 2½ minutes and automatically dumped the prepared concrete into a bucket waiting on a flatcar nearby.

"A 10-ton diesel locomotive moved it swiftly along a trestle to the form prepared for the first pour. A huge crane picked the bucket from the flatcar, swung it through the air until it was directly over the form and lowered it several feet. Then Governor Martin pulled the cord."

Governor Clarence D. Martin tipping the concrete bucket at the "Official First Pour Ceremony."



Today
1975

Grand Coulee Dam had awaited the completion of its Third Powerplant since construction began in 1967. The first of six generating units housed by the powerplant went on the line in October.

The generators at the Third Powerplant are the largest ever built in the United States, and their capacity, together with the capacity of existing power-producing facilities at Grand Coulee and future units, will make Grand Coulee the largest hydroelectric power-producing facility in the world.

In 1962, when the Third Powerplant was envisioned, 300 megawatt generating units were considered to be the maximum practical size. But further study indicated that larger units would be feasible. So plans were made for the Third Powerplant to have three generating units of 600 megawatt capacity, and three of 700 megawatt capacity.

To feed these gigantic generators, huge turbines and enormous amounts of water would be needed. Thus, the entire Third Powerplant project has been an exercise in "bigness." For example, the penstocks used in this project are 40 feet in diameter, through which 30,000 cubic feet of water per second plunge. The bolts which connect the runners to the drive shafts of the generators are 8¼ inches in diameter and together with their nuts, weigh 960 pounds each.

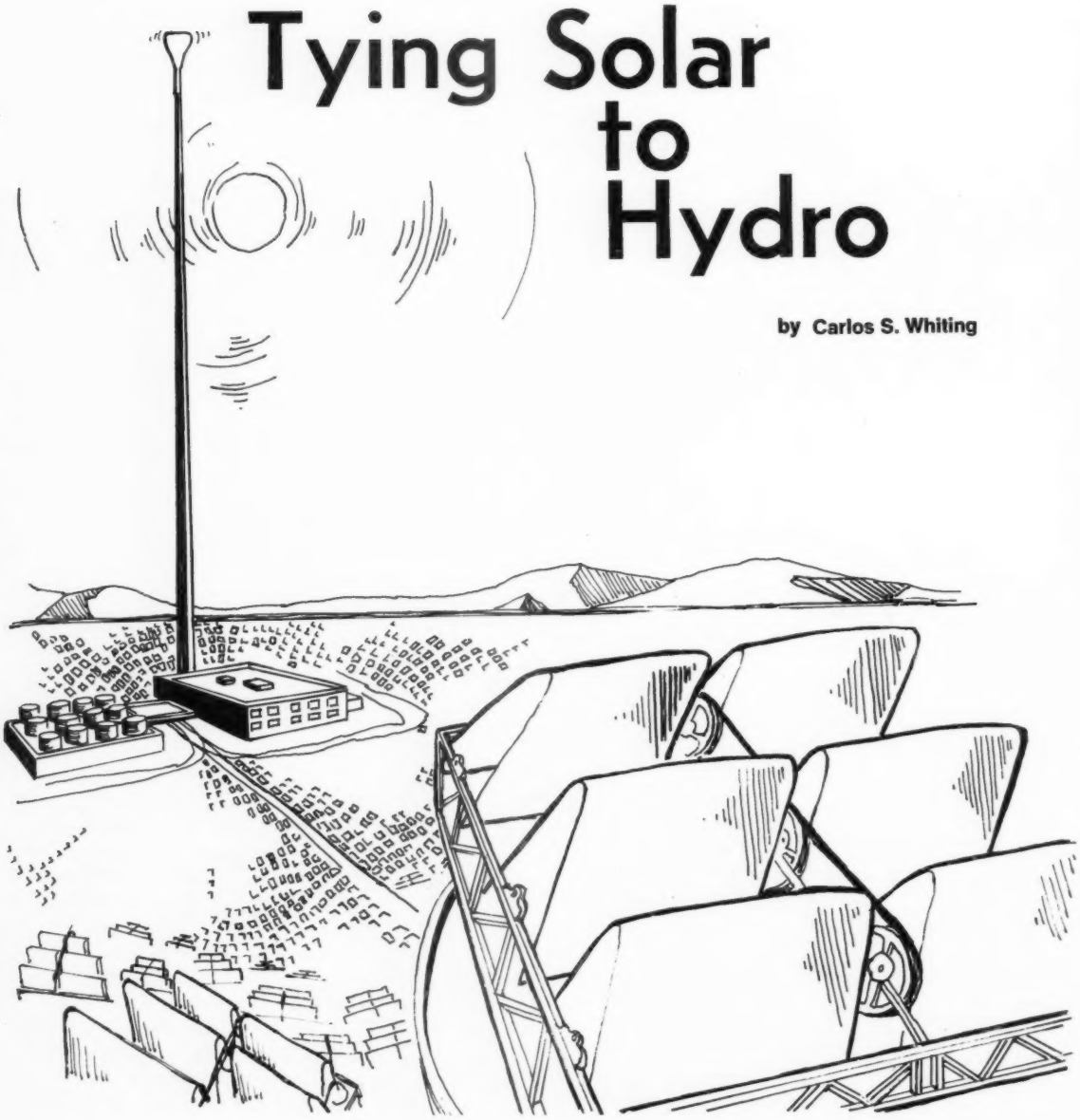
Because of the tremendous size of the equipment, it was necessary to ship it to the site in pieces where it was assembled.

All six generating units of the Third Powerplant are expected to be in operation by 1978.

The Third Powerplant and Forebay Dam, 1975.

Tying Solar to Hydro

by Carlos S. Whiting



Of all the alternatives for energy to meet mankind's ever-growing needs, the one with the greatest potential is solar power. Already, with considerable assistance from man, solar energy meets 14 percent of the Nation's electric demand.

This is accomplished through hydroelectric generation, for hydropower is a form of solar power. Tapping the energy in the Earth's hydrologic cycle—that great solar-driven engine of wind, rain, and sea—hydroelectric power has the potential to make other forms of solar energy economically feasible within the near future.

The virtue of hydroelectric energy in this respect is that hydro is presently the only feasible means of storing great quantities of electric energy for almost instant use upon demand. Water backed up in a large lake behind a dam, with its associated hydroelectric powerplant below, is a literal reservoir of energy. When electric power is needed on the line to meet peak demands for energy, as in early evening, valves are opened, water thunders through penstocks, turbines spin, and within seconds huge electric generators are producing power. The system works like a huge battery.

Carlos S. Whiting is a Washington, D.C., environmentalist and a writer on natural resources, currently with the Bureau of Reclamation

More and more, existing hydroelectric plants as well as new ones are being used to meet peak energy demands in this fashion rather than operating on a round-the-clock basis to meet the entire load.

Another form of hydro, important to the future use of other forms of solar energy, is pumped storage. Pumped storage is water pumped to a storage pool above the plant at a time when customer demand for energy is low (as during the middle of the night) and then allowed to fall back through combination pump-generators at breakfast or dinner time when customer demand is high and a heavy load is placed on the system.*

We can tap the energy in the Earth's hydrologic cycle—that great solar-driven engine of wind, rain, and sea.

Tying solar generation (available in the heat of the day when solar power is at its peak efficiency) with pumped storage would work in a similar way. A solar-energy plant would help meet high daytime demand and, if engineered and constructed with sufficient capacity to do so, would have surplus energy that could be used to pump water into pumped-storage hydrosystems for use when the sun was obscured by weather or at night.

Recently, the Federal Power Commission identified 155 potential pumped storage hydroelectric power sites in a four-State area of the Pacific Southwest as having an ultimate installed capacity of 341,100 megawatts. The Nation has 8,200 megawatts of installed capacity in 25 pumped storage plants. It appears that within 20 years this may easily quintuple to 41,000 megawatts. The tremendous potential for pumped storage is evident, especially in an area where solar radiation reaching the Earth's surface is greater than almost anywhere else in the United States.

Realizing some of the potential in tying solar power to hydropower may not be as theoretical or as far in the future as one might think. The Bureau of Reclamation is one agency ready and willing to make that tie within a very few years.

* See the article, "Hydroelectric Power—Using Water to Save Oil" on page 16.

In fact, the Bureau has expressed to the Energy Research and Development Administration interest in the possibility of integrating the output of a solar powerplant in Yuma County, Ariz., with that of an existing hydroelectric power system.

Reclamation is committed by Congressional action and treaty obligations with Mexico to build a huge desalting plant to remove excess salts from irrigation return flows now going into Mexico by way of the Colorado River. Scheduled for completion in 1979, this desalting plant, part of the Colorado River Basin Salinity Control project, will require major additional electric generation in the area. Of several ideas being considered, one of the most interesting is the construction of a solar power tower in sun-drenched Yuma County.

Another form of hydro, important to the future use of other forms of solar energy, is pumped storage.

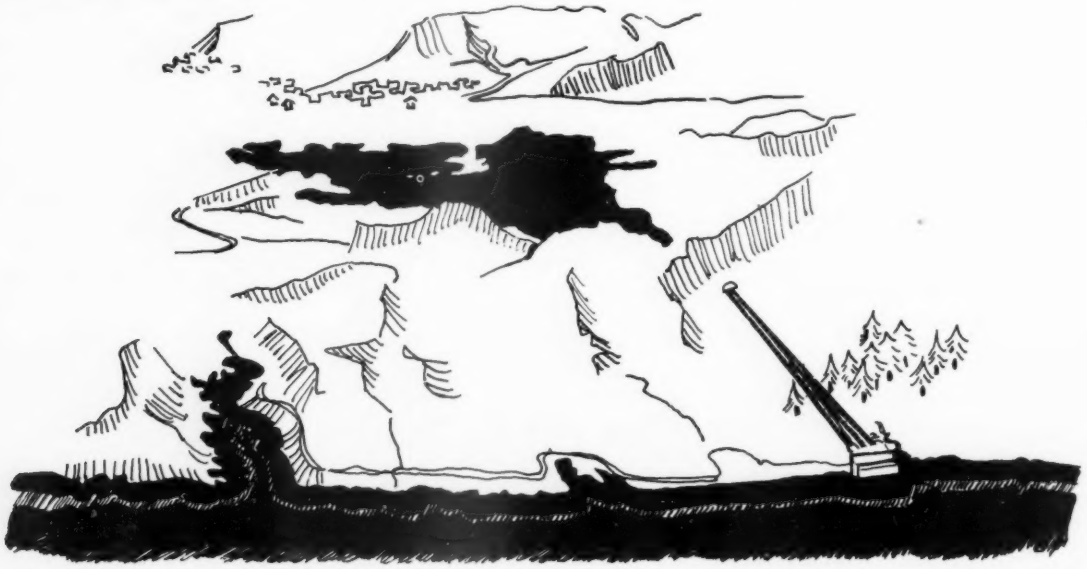
One of the essential features of one concept of a solar powerplant is the power tower. A solar power tower is a concrete structure several hundred feet high, topped by a ceramic "bulb" which receives radiation reflected from a mile-square field of heliostats. The solar heat generates steam, which drives a conventional steam-electric powerplant.

Imaginative and innovative as it is, a solar power tower (or other similar solar-steam-electric generation facility) could not only meet the energy requirements of the desalting plant but could also serve as a prototype solar-energy facility within the present national commitment to build such a prototype somewhere.

A solar-power prototype plant of about 10 megawatts is one of the possibilities for a demonstration plant to be constructed under the Solar Energy Research Development and Demonstration Act of 1974. Such a plant would meet some of the energy needs for the Yuma Desalting Plant. The possibility of constructing such a demonstration plant where it would meet a need for energy, and where a costly conventional powerplant would have to be built in any event, is being considered.

While a larger solar powerplant under the Solar Energy Research Development and Demonstration Act would require specific approval of Congress, preliminary data indicate that a solar plant of up to 200 megawatts might be technically and economically feasible. Further, it could be tied into the huge Hoover Dam and Powerplant complex (working as pumped storage) to demonstrate the possibilities in a solar-power and hydropower tie.

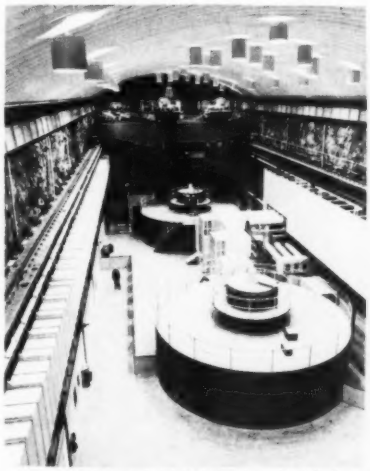
Solar power truly is a possible energy source for the near future.



Water
Quiz

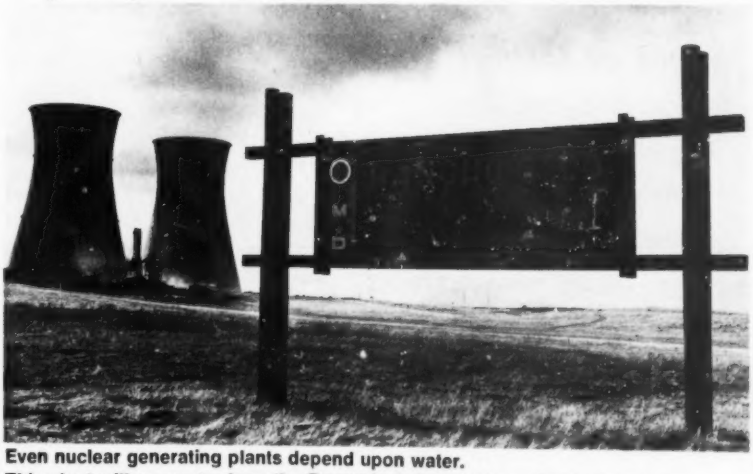
1. The two conventional types of powerplants are hydroelectric and thermal powerplants. True or false?
2. What is the major role of water in each of these two types of powerplants?
3. What are two basic sources of energy used in a thermal powerplant?
4. The term "head," as used in low-head, medium-head, or high-head powerplant refers to:
   a) the capacity at which a plant's power generating facilities are operating
   b) the relative speed of water as it enters a plant's power generating facility
   c) the capacity of a plant's electrical generators
   d) the vertical distance between the water surface upstream and downstream from the powerplant.
5. Water used in an atomic powerplant
   a) is converted into steam which drives the turbines
   b) cools turbine condensers
   c) acts as a moderator to slow down neutrons, thereby increasing the efficiency of the fission process
   d) all of the above

Answers on page 32.



Morrow Point Powerplant's two generating units of 60,000 kW each.

The powerhouse open cut at the Curecanti Unit, Morrow Point Dam.



Even nuclear generating plants depend upon water.
This plant will use water from the Bureau's Auburn-Folsom South Canal.

Continued from page 22.

bined metropolitan areas of New York City and Los Angeles. If the hydroelectric energy produced at Reclamation's powerplants were produced from fossil fuels, it would require annually the equivalent of either 70 million barrels of oil or 18.4 million tons of coal, or 418 billion cubic feet of natural gas.

In addition to the power produced at its own hydroelectric plants located along major rivers in the 17 Western States, the Bureau of Reclamation markets power from six Corps of Engineers' plants in the Missouri River Basin, one plant owned by the International Boundary and Water Commission in Texas, and a portion of the output from the Navajo generating station of the Central Arizona project.

One of the largest hydroelectric projects currently under construction is the Bureau of Reclamation's Third Powerplant at Grand Coulee Dam in Washington State.

One of the largest hydroelectric projects currently under construction is the Bureau of Reclamation's Third Powerplant at Grand Coulee Dam in Washington State. Grand Coulee generators in the left and right powerplants currently have a capacity of 2,229,000 kW. In addition, there are 100,000 kW of pump-generating capacity at a separate pumping-generating plant with an additional 200,000 kW scheduled. Another 3,900,000 kW is to be installed in the Third Powerplant, with the first generator having gone on the line on October 11, 1975. Studies are underway on the possible addition of more units at Grand Coulee, which ultimately is expected to become the world's largest hydroelectric power complex with a total of about 10 million kW of installed capacity.

Other large hydroelectric generating facilities have been completed and are under construction by the Army Corps of Engineers on the Kootenai River in Montana and the Snake River in Washington and Idaho.

Although the Nation's hydroelectric capacity continues to grow, the amount of hydroelectric power as a percentage of total U.S. electric-generating capacity is expected to decline because of increased generation from all sources—coal, gas, and nuclear.

Hydropower is not an instant solution to the Nation's energy problems. There are limits to its development, both from an environmental and an economical standpoint. And there are limits because of competing demands for water, especially in the West where many of the potential, undeveloped hydropower sites are located.

Although the capability of installed equipment to generate power during a specific period of time can be increased, the actual output of energy at a dam is determined by the amount of water available and the "head" (the distance the water falls) of the water which operates the turbine generators. Power includes capacity (kilowatts) and energy (kilowatt-hours). Thus, a given amount of water falling a given distance will produce a certain amount of energy. But depending on whether that happens in one hour or in one week will determine the maximum capacity, or kilowatts, that can be produced. Therefore, unless water is being spilled from time to time, installation of additional units will not increase energy output.

The need for more energy which is both cleaner and less expensive demands that every possibility be explored.

Even so, the installation of additional capacity at several existing plants, where feasible, would increase the availability of hydropower for peaking purposes and save finite fossil fuel.

This old and proven method of creating electricity through controlling the force of falling water can play a significant and beneficial role in reducing U.S. dependence on fossil fuels. The need for more energy which is both cleaner and less expensive demands that every possibility be explored.

A program to increase the United States' self-sufficiency would not only benefit the economy, but the accompanying construction and operation stages would significantly increase employment. A program to develop hydroelectric energy represents sound resource development for the future. eia

News Notes

Catino Named Assistant Regional Director

Michael A. Catino has been appointed Assistant Regional Director, Mid-Pacific Region.

Catino began his career with the Bureau in 1945 as a civil engineer working on the Contra Costa Canal, the first unit of the Central Valley project. His work in the Regional Office began in 1950 as a scheduling officer in the Programs and Finance Division. He was appointed Regional Program Coordination and Finance Officer for the Mid-Pacific Region in 1964.

During his career with the Bureau, he has been cited for outstanding performance four times, and received a Department of the Interior Award for Meritorious Service in 1974.

He is a past director of the Federal Government Accountants Association and a director of the American Association of Cost Engineers. He is a member of the U.S. Committee on Irrigation, Drainage, and Flood Control.

Prior to joining the Bureau, Catino served with the Corps of Engineers during World War II and was awarded the Bronze Star Medal while serving in the Philippines.

Catino attended Grant Union Technical School in Sacramento, the University of California Extension, and Sacramento State College. In 1960 he participated in the Department of the Interior's Management Development Program.

Hall Named Regional Director

Joe D. Hall has been named Regional Direcor of the Lower Missouri Region, headquartered in Denver.

Prior to this appointment, Hall was head of the Bureau's Oklahoma City Planning Office in the Southwest Region.

Hall's career with the Bureau began in 1961 when he worked on the Canadian River project in Amarillo, Tex. He remained with

that project's Field Engineering Division for 6 years, coordinating the construction of an aqueduct and a reservoir. In 1967 he was transferred to the Bureau's Topeka, Kans., Office where he coordinated the "Kansas State Water Plan Studies." He joined the Oklahoma City Development Office in 1971 and was soon promoted to area planning officer with the responsibility for coordinating Bureau planning activities for the State of Oklahoma and portions of Kansas and Texas.

Hall received a bachelor's degree in civil engineering from Texas A&M University in 1957. He is a registered Professional Engineer and a member of the American Society of Civil Engineers.

Hall is a native of Dallas, Tex., and is a past District Governor of Toastmasters International in Kansas and western Missouri.

Prior to his Government career, Hall was the co-owner of a construction company in Amarillo, Tex.

Reclamation's Hydroelectric Power In Review

The Bureau of Reclamation's electric power operations in the Western States last year produced record-high revenues and enough clean energy to meet the needs of a population nearly equal to the combined metropolitan areas of New York City and Los Angeles.

Kent Frizzell, Acting Secretary of the Interior, said that Reclamation's 1974 power statistics "reflect the important role hydroelectric power plays in meeting the Nation's demand for clean energy."

Lopez Appointed Regional Director

Manuel Lopez, Jr., has been appointed Regional Director of the Lower Colorado Region, headquartered in Boulder City, Nev. Lopez has been serving as Assistant Regional Director since June of last year.

Lopez is a native of Tampa, Fla. His Government career spans 31 years. He began as a clerk in the Bureau's Chief Engineer's Office in Denver. After receiving a bachelor's degree in 1951 and a master's degree in 1957, both in civil engineering from the University of Colorado, Lopez worked for the Bureau as a mechanical engineer at Hungry Horse Dam in Montana, and as a bridge engineer, mechanical design engineer, and supervisory mechanical engineer on the Chief Engineer's staff in Denver.

In 1967, Lopez left the Bureau to become resident engineer with the then Office of Saline Water (now, Office of Water Research and Technology), Bolsa Island project, Los Angeles. He then worked in the Washington, D.C., Office of Saline Water as coordinator and planner and later as supervisor.

Lopez returned to the Bureau as Assistant Chief of the Division of Planning Coordination in the Engineering and Research Center in Denver before his appointment as Assistant Regional Director.

Lopez is the recipient of the Department of the Interior's Meritorious Service Award and several citations for superior and outstanding performance.

Answers to Water Quiz

1. True
2. In a hydroelectric powerplant, falling water is the source of mechanical energy which drives the turbines. In a thermal powerplant, water is converted into steam which drives the turbines.
3. Fossil fuel (coal, petroleum, natural gas), and nuclear fuel (uranium 235).
4. d
5. d

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Continued from page 5.

". . . singing their Lorelei song to cynical industry . . .," and ". . . piling on more power in an area that already has twice as much developed power as it can use."

Such dire forecasts were proven wrong even before the authorized generating capacity could be installed in the 1940's. As the dam neared completion, World War II caused an unexpected demand for electrical power for production of materials for military use.

On March 22, 1941, the dam's two small station service generators were put into service to provide nearly 11,000 kW of needed production capacity. On October 4, 1941, the first of the authorized 108,000 kW generators was put on the line. Five similar generators were rushed to completion and another two which had been scheduled for installation in Shasta Dam in California were shifted temporarily to Grand Coulee.

Instead of being a white elephant or a waste, the immense amount of power then available at Grand Coulee made possible the Hanford atomic installation at Richland, Wash. This power proved to be a major factor in the manufacture of atomic products and helped bring an end to World War II. The availability of the hydropower also led to location in the Pacific Northwest area of aluminum plants which produced metal vital to construction of airplanes for World War II use and which have made a major industrial contribution to continuing development of the Pacific Northwest.

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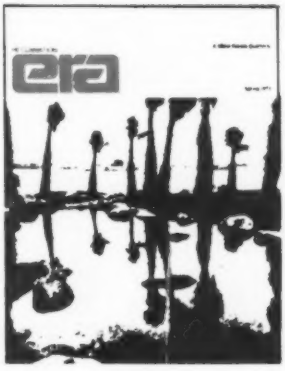

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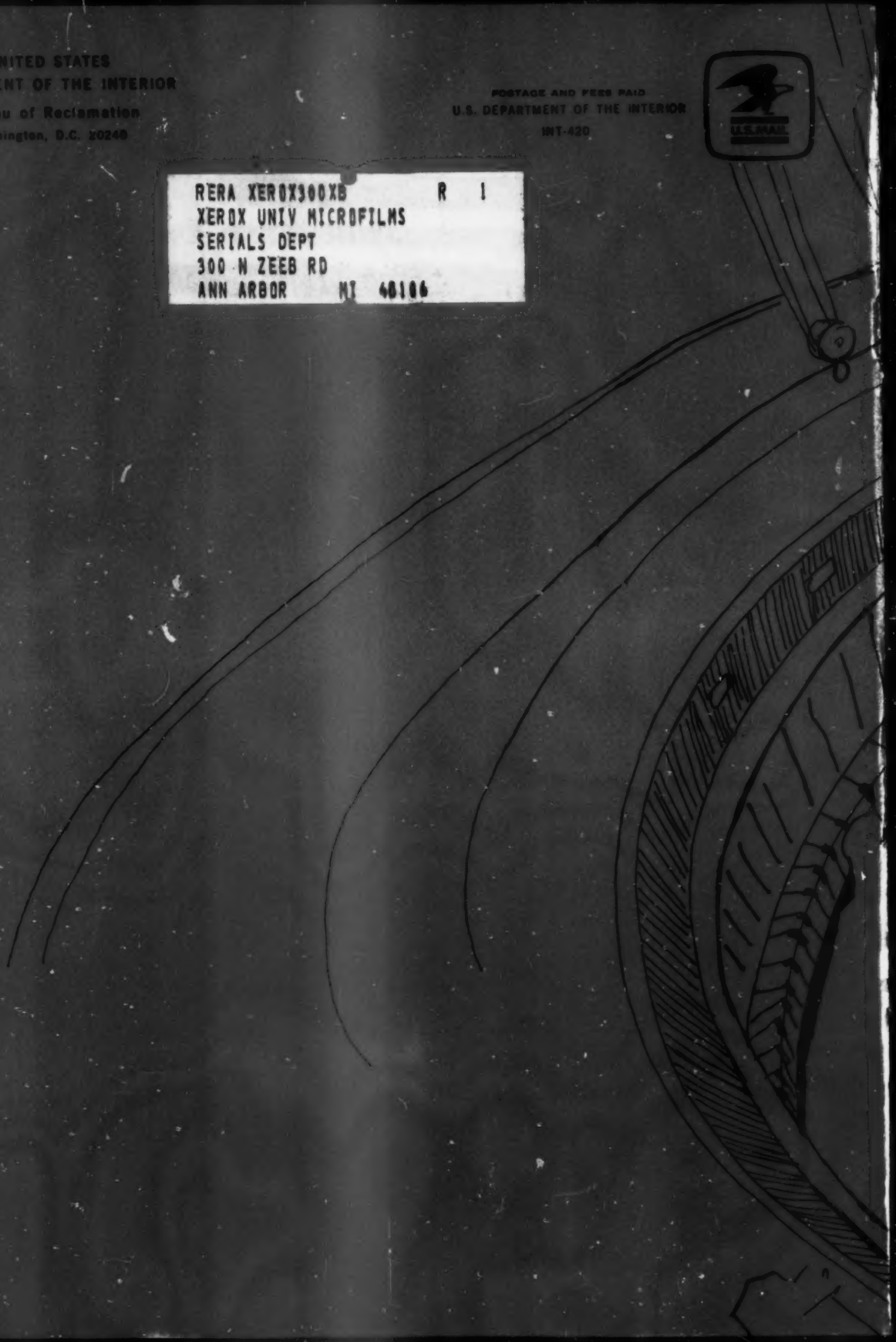
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